

FORM PTO-1390 (REV 10-2000)		U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE		ATTORNEYS DOCKET NUMBER <b>0670-251</b>	
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371				U.S. APPLICATION NO. (if known, see 37 CFR 1.5)	
				<b>09/720028</b>	
INTERNATIONAL APPLICATION NO. <b>PCT/JP00/02662</b>		INTERNATIONAL FILING DATE: <b>April 24, 2000</b>		PRIORITY DATE CLAIMED: <b>April 22, 1999</b>	
TITLE OF INVENTION  <b>SPEAKER DIAPHRAGM</b>					
APPLICANT(S) FOR DO/EO/US  <b>Junichi HAYAKAWA, Masaya KASAI</b>					
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:					
<ol style="list-style-type: none"> <li>1. <input checked="" type="checkbox"/> This is a <b>FIRST</b> submission of items concerning a filing under 35 U.S.C. 371.</li> <li>2. <input type="checkbox"/> This is a <b>SECOND</b> or <b>SUBSEQUENT</b> submission of items concerning a filing under 35 U.S.C. 371.</li> <li>3. <input checked="" type="checkbox"/> This is an express request to promptly begin national examination procedures (35 U.S.C. 371(f)).</li> <li>4. <input checked="" type="checkbox"/> The US has been elected by the expiration of 19 months from the priority date (PCT Article 31).</li> <li>5. <input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 371(c)(2)) <ol style="list-style-type: none"> <li>a. <input type="checkbox"/> is attached hereto (required only if not communicated by the International Bureau).</li> <li>b. <input checked="" type="checkbox"/> has been communicated by the International Bureau.</li> <li>c. <input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US).</li> </ol> </li> <li>6. <input checked="" type="checkbox"/> An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).</li> <li>7. <input checked="" type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)). <ol style="list-style-type: none"> <li>a. <input type="checkbox"/> are attached hereto (required only if not communicated by the International Bureau).</li> <li>b. <input type="checkbox"/> have been communicated by the International Bureau.</li> <li>c. <input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired.</li> <li>d. <input checked="" type="checkbox"/> have not been made and will not be made.</li> </ol> </li> <li>8. <input type="checkbox"/> An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).</li> <li>9. <input checked="" type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).</li> <li>10. <input type="checkbox"/> An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).</li> </ol>					
<b>Items 11 to 16 below concern document(s) or information included:</b>					
11. <input checked="" type="checkbox"/> An Information Disclosure Statement under 37 CFR 1.97 and 1.98.					
12. <input checked="" type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.					
13. <input checked="" type="checkbox"/> A FIRST preliminary amendment.					
<input type="checkbox"/> A SECOND or SUBSEQUENT preliminary amendment.					
14. <input type="checkbox"/> A substitute specification.					
15. <input type="checkbox"/> A change of power of attorney and/or address letter.					
16. <input checked="" type="checkbox"/> Other items or information:					
International Search Report					
Four (4) Sheets of Formal Drawings					

U.S. APPLICATION NO (If known, see 37 C.F.R. 1.50) <b>09/720028</b>		INTERNATIONAL APPLICATION NO <b>PCT/JP00/02662</b>		ATTORNEYS DOCKET NUMBER: <b>0670-251</b>	
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17. <input checked="" type="checkbox"/> The following fees are submitted: <b>BASIC NATIONAL FEE (37 CFR 1.492(a)(1) - (5)):</b> Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO .....#1000.00  International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO .....\$860.00  International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(3)) paid to USPTO .....\$710.00  International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) .....\$690.00  International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) .....\$100.00  <b>ENTER APPROPRIATE BASIC FEE AMOUNT =</b> \$860.00				<b>CALCULATIONS</b>		<b>PTO USE ONLY</b>																								
Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(e)).  <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 20%;">CLAIMS</th> <th style="width: 20%;">NUMBER FILED</th> <th style="width: 20%;">NUMBER EXTRA</th> <th style="width: 20%;">RATE</th> <th style="width: 20%;"></th> </tr> <tr> <td>Total claims</td> <td>12 - 20 =</td> <td>0</td> <td>X \$18.00</td> <td>\$</td> </tr> <tr> <td>Independent claims</td> <td>2 - 3 =</td> <td>0</td> <td>X \$80.00</td> <td>\$</td> </tr> <tr> <td colspan="4">MULTIPLE DEPENDENT CLAIM(S) (if applicable) + \$270.00</td> <td>\$270.00</td> </tr> <tr> <td colspan="4"><b>TOTAL OF ABOVE CALCULATIONS =</b></td> <td>\$1,130.00</td> </tr> </table> <input type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.  <b>SUBTOTAL =</b> \$1,130.00  Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).  <b>TOTAL NATIONAL FEE =</b> \$1,130.00  Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property +  <b>TOTAL FEES ENCLOSED =</b> \$1,170.00				CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		Total claims	12 - 20 =	0	X \$18.00	\$	Independent claims	2 - 3 =	0	X \$80.00	\$	MULTIPLE DEPENDENT CLAIM(S) (if applicable) + \$270.00				\$270.00	<b>TOTAL OF ABOVE CALCULATIONS =</b>				\$1,130.00	Amount to be refunded: \$  Charged: \$	
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Total claims	12 - 20 =	0	X \$18.00	\$																										
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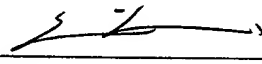
a. ☒ A check in the amount of \$1,170.00 to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. \_\_\_\_\_ in the amount of \$ \_\_\_\_\_ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 19-2380. A duplicate copy of this sheet is enclosed.

**NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.**

SEND ALL CORRESPONDENCE TO:

  
 SIGNATURE  
  
Eric J. Robinson  
 NAME  
  
38,285  
 REGISTRATION NUMBER

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re New Patent Application of )  
Junichi HAYAKAWA et al. )  
International Application No. PCT/JP00/02662 ) Attn: US/DO/EO  
International Filing Date: April 24, 2000 )  
For: SPEAKER DIAPHRAGM ) Date: December 20, 2000

PRELIMINARY AMENDMENT

Honorable Assistant Commissioner for Patents  
Washington, D.C. 20231

Sir:

Please preliminarily amend the subject application as follows:

IN THE CLAIMS:

Please amend claims 4 and 6 as follows:

4. (Amended) A speaker diaphragm according to claims 1 or 2 [claim 1, 2 or 3,] wherein a bottom area of the recess is made thicker than another area.

6. (Amended) A speaker diaphragm according to any one of claim[s] 1 [to 5], wherein the speaker diaphragm is manufactured by ejection molding of material containing polypropylene as a main composition.

Please add new claims 7 to 10 as follows:

--7. A speaker diaphragm according to claim 2, wherein the speaker diaphragm is manufactured by ejection molding of material containing polypropylene as a main composition.

8. A speaker diaphragm according to claim 3, wherein the speaker diaphragm is manufactured by ejection molding of material containing polypropylene as a main composition.

9. A speaker diaphragm according to claim 4, wherein the speaker diaphragm is manufactured by ejection molding of material containing polypropylene as a main composition.

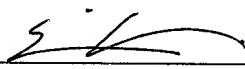
10. A speaker diaphragm according to claim 5, wherein the speaker diaphragm is manufactured by ejection molding of material containing polypropylene as a main composition.--

REMARKS

Claims 4 and 6 have been amended to correct the improper multiple dependencies therein. New claims 7-10 have been added to complete the scope of applicants' protection.

Examination on the merits is requested.

Respectfully submitted,

  
\_\_\_\_\_  
Eric J. Robinson  
Registration No. 38,285

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## SPEAKER DIAPHRAGM

### 1. Field of the Invention

The present invention relates to a speaker diaphragm, and more particularly to a speaker diaphragm having a good quality of radiation sounds and an excellent outer appearance.

Conventionally, a speaker diaphragm is mechanically reinforced by using ribs or the like. Such ribs are used to prevent distortion of radiation sounds by suppressing generation of division vibrations of the speaker diaphragm and flattening the frequency characteristics.

An example of a speaker diaphragm having such ribs is shown in the plan view of Fig. 6.

As shown in Fig. 6, this speaker diaphragm is formed with radially disposed projections 30 which are used as ribs. The projections 30 of the speaker diaphragm increases the mechanical strength along the radial direction of the speaker diaphragm to suppress generation of division vibrations having nodes along the circumferential direction.

In Japanese Utility Model laid-open No. 2-8249 gazette, a cone type speaker diaphragm integrally formed with spiral ribs is

5 disclosed.

## 2. Description of the Related Art

A speaker diaphragm having ribs such as those shown in Fig. 6 is not mechanically reinforced in the area where the ribs are not formed. Therefore, the mechanical strength of the speaker diaphragm is not efficiently improved over the whole area. A speaker diaphragm having conventional ribs cannot efficiently suppress division vibrations, particularly division vibrations having nodes along the radial direction.

When a speaker diaphragm having ribs such as those shown in Fig. 6 vibrates at a large amplitude, an air flow on the surface of the speaker diaphragm is linear from the outside to inside, similar to a speaker diaphragm without ribs. Therefore, while the speaker diaphragm vibrates at a large amplitude, air is likely to press the central area of the speaker diaphragm, and the motion of the speaker diaphragm is hindered to thereby lower the quality of radiation sounds.

The ribs of a conventional speaker diaphragm such as those shown in Fig. 6 have linear shapes and a viewer receives only a simple impression.

25 Also in the case of the cone type speaker diaphragm disclosed

5 in Japanese Utility Model laid-open No. 2-8249 gazette, ribs are disposed locally and the mechanical strength cannot be increased over the whole area of the cone type speaker diaphragm. It is not possible to mitigate an air pressure in the central area of the speaker diaphragm.

10 The present invention has been made under the above-described circumstances. It is an object of the present invention to provide a speaker diaphragm having a good quality of radiation sounds.

It is another object of the present invention to provide a  
15 speaker diaphragm having an excellent outer appearance.

#### SUMMARY OF THE INVENTION

In order to achieve the above objects, according to a first aspect of the present invention, there is provided a speaker diaphragm having a generally cone shape, comprising:

20 a plurality of projections forming a periodical structure along a circumferential direction in a slanted area of the speaker diaphragm, each projection extending radially from a central area to an edge portion and curving along the circumferential direction as the speaker diaphragm comes near to the edge portion; and

25 a plurality of recesses formed between the plurality of

5 projections,

wherein at least one surface is curved in an area from each projection to each recess.

The projection extending radially in the slanted area curves along the circumferential direction as the speaker diaphragm comes  
10 near to the edge portion. While the speaker diaphragm vibrates at a large amplitude and the central area and the slanted area move toward the bottom side, a force along the circumferential direction can be applied to air which is likely to concentrate upon the central area, so that the air can be rotated. An air pressure to the speaker  
15 diaphragm can be lowered so that the quality of radiation sounds can be improved.

One surface in an area from each projection to each recess preferably has a bent portion. The mechanical strength of the speaker diaphragm along the radial direction can therefore be  
20 increased to suppress division vibrations and improve the quality of radiation sounds.

The odd number of projections as counted along the circumferential direction are preferably formed, and the projection has preferably a cross section like a screw propeller. Division  
25 vibrations having nodes in the radial direction can be forcibly



5 suppressed and the quality of radiation sounds can be improved.

A bottom area of each recess is preferably made thicker than another area. Generation of division vibrations in the slanted area can be forcibly suppressed and the quality of radiation sounds can be improved.

10 According to a second aspect of the present invention, there is provided a speaker diaphragm having a general cone shape, the speaker diaphragm having projections and recesses forming a screw propeller shape to give a force along the circumferential direction to air flowing toward a central area of the speaker diaphragm.

15 According to the present invention, a force along the circumferential direction is applied to air which is likely to flow toward the central area, so that the air pressure to the central area can be lowered. Sounds can be efficiently radiated and the quality of sounds can be improved.

20 The speaker diaphragm is preferably manufactured by ejection molding of material containing polypropylene as a main composition.

The speaker diaphragm having a characteristic structure can be manufactured easily. By using a variety of colors, an excellent outer appearance with a visually strong impression can be provided.

5 BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a plan view of a speaker diaphragm according to an embodiment of the invention.

Fig. 2 is a plan view showing each divided area of the speaker diaphragm of the embodiment.

10 Fig. 3 is a cross sectional view of the speaker diaphragm of the embodiment.

Fig. 4 is a cross sectional view of the speaker diaphragm of the embodiment.

15 Fig. 5 is a diagram illustrating an air flow near the surface of the speaker diaphragm of the embodiment.

Fig. 6 is a plan view showing an example of a conventional speaker diaphragm.

EMBODIMENT OF THE INVENTION

20 A speaker diaphragm according to an embodiment of the invention will be described with reference to the accompanying drawings.

Fig. 1 is a plan view of a speaker diaphragm 10 according to an embodiment of the invention. Fig. 2 is a plan view showing each  
25 divided area having a structural difference of the speaker diaphragm

5 10 so as to facilitate the description relating to the speaker diaphragm 10.

The speaker diaphragm 10 has, for example, a diameter of about 30 cm and can be manufactured by ejection molding of resin containing polypropylene as its main composition. As shown in Fig. 10 2, the speaker diaphragm 10 is constituted of a central area 1, a slanted area 2, and an edge portion 3.

The central area 1 has a voice coil bobbin, for example, adhered at the bottom thereof and is used as a vibration generation source for vibrating the speaker diaphragm 10.

15 The slanted area 2 propagates vibrations in the central area 1 to peripheral air. As shown in Fig. 1, the slanted area 2 has a plurality of projections typically represented by a peak line 4 and a plurality of recesses typically represented by a bottom line 5.

In the example shown in Fig. 1, the slanted area 2 is has three 20 projections typically represented by the peak line 4 and three recesses typically represented by the bottom line 5. The slanted area 2 can efficiently suppress division vibrations, particularly four-division vibrations considerably degrading the characteristics of the speaker diaphragm 10, among division vibrations having nodes 25 along the radial direction. The slanted area 2 having three

5 projections typically represented by the peak line 4 and three  
recesses typically represented by the bottom line 5 can also  
efficiently suppress division vibrations other than four-division  
vibrations.

Fig. 3 is a cross sectional view of the speaker diaphragm 10 as  
10 taken along line A-A shown in Fig. 1.

As shown in Fig. 3, the speaker diaphragm 10 has a generally  
cone shape basing upon a parabola shape, with the projection  
typically represented by the peak line 4. A broken line in Fig. 3  
indicates a ridge of the projection drawn by the peak line 4.

15 As indicated by the peak line 4 shown in Fig. 1, the projection  
of the speaker diaphragm 10 extends radially from the central area 1  
to the edge portion 3, and curves along the circumferential direction  
as it comes near to the edge portion 3. Namely, the projection and  
recess of the speaker diaphragm 10 form a shape like a screw  
20 propeller. Therefore, as the speaker diaphragm 10 vibrates, a  
rotation force is applied to the air flow on the surface of the speaker  
diaphragm 10.

Fig. 4 is a cross sectional view of the slanted area 2 of the  
speaker diaphragm 10 circumferentially taken along line B-B shown  
25 in Fig. 1, as viewed along a direction indicated by an arrow D in Fig.

5 2.

As shown in Fig. 4, one surface of the speaker diaphragm 10 extending from the projection represented by the peak line 4 to the recess is curved. The other surface opposite to the curved surface is, for example, curved from the peak line 4 to the bottom line 5 and bent at the bottom line 5. With this shape, the speaker diaphragm 10 has an emphasized outer appearance like the screw propeller and increases the mechanical strength of the projection functioning as a rib.

Also as shown in Fig. 4, a bottom area 6 of the recess of the speaker diaphragm 10 is made thicker than the other area. Therefore, the speaker diaphragm 10 can prevent division vibrations in the recess and improve the quality of radiation sounds.

The edge portion 3 shown in Fig. 2 is used for fixing the speaker diaphragm 10 to an audio apparatus. For example, the speaker diaphragm 10 is fixed to a frame with screws or to a cabinet of a speaker system with adhesive.

A specific example of the speaker diaphragm applied to an audio apparatus according to the embodiment of the invention will be described.

25 In mounting the speaker diaphragm 10 on the audio

5 apparatus, a process similar to that used for a general speaker diaphragm can be used for mounting it. Specifically, the speaker diaphragm 10 is fixed to a frame with screws or to a cabinet of a speaker system with adhesive, and a voice coil bobbin is adhered to the bottom of the central area 1, to thereby constitute a magnetic  
10 circuit. By flowing current in the magnetic circuit, the speaker diaphragm 10 vibrates to generate radiation sounds.

Generally, while a speaker diaphragm vibrates at a large amplitude and moves toward the bottom side thereof, an atmospheric pressure in the central area of the speaker diaphragm  
15 lowers. Therefore, while the speaker diaphragm moves toward the bottom side, there is a tendency that air concentrates from the edge portion to the central area.

According to the speaker diaphragm 10 of the embodiment of this invention, it has a three-dimensional structure like the screw  
20 propeller, air flowing toward the central area 1 of the speaker diaphragm 10 can receive a rotation force.

Fig. 5 shows an air flow near the surface of the speaker diaphragm 10 while the speaker diaphragm 10 vibrates at a large amplitude and the central area 1 and slanted areas 2 thereof move  
25 toward the bottom side.

5       As shown in Fig. 5, in such a case, air which is likely to  
concentrate upon the central area 1 of the speaker diaphragm 10  
near the surface thereof, receives the force along the circumferential  
direction by the projections of the speaker diaphragm 10 typically  
represented by the peak line 4. In other words, the projections of  
10 the speaker diaphragm 10 give the rotation force to the air which is  
likely to concentrate upon the central area of the speaker diaphragm  
10.

It is therefore possible to lower the air pressure to the central  
area 1 of the speaker diaphragm 10 and efficiently radiate sounds at  
15 a large sound volume.

The slanted area 2 has three projections typically represented  
by the peak line 4 and three recesses typically represented by the  
bottom line 5. Therefore, the speaker diaphragm 10 can forcibly  
suppress division vibrations, particularly four-division vibrations  
20 considerably degrading the characteristics of the speaker diaphragm  
10, among division vibrations having nodes along the radial  
direction.

The frequency characteristics of the speaker diaphragm 10 can  
therefore be made flat and the quality of radiation sounds can be  
25 improved.

5 Further, the bottom area 6 of the recess is made thicker than the other area so that division vibration in the recess of the speaker diaphragm 10 can be suppressed.

The frequency characteristics of the speaker diaphragm 10 can therefore be made flat and the quality of radiation sounds can be  
10 improved.

Furthermore, the recess of the speaker diaphragm 10 is bent along the bottom line 5 to increase the mechanical strength of the speaker diaphragm 10 along the radial direction. Division vibrations having node along the circumferential direction can  
15 therefore be suppressed.

The frequency characteristics of the speaker diaphragm 10 can therefore be made flat and the quality of radiation sounds can be improved.

Still further, the speaker diaphragm 10 can be manufactured  
20 by ejection molding of polypropylene. It is therefore easy to use a variety of colors during manufacture processes, so that a visually good outer appearance can be obtained. The speaker diaphragm 10 has the structure greatly different from that of a conventional speaker diaphragm and has a shape like the screw propeller. A  
25 strong visual impression can be given.



5           As described so far, in the speaker diaphragm 10, the slanted area has a plurality of projections and recesses, forming a three-dimensional structure like the screw propeller. The speaker diaphragm 10 can therefore lower the air pressure in the central area 1 by giving the rotation force to the air which is likely to concentrate  
10 upon the central area 1. It is also possible to forcibly suppress division vibrations having nodes along the radial and circumferential directions. The speaker diaphragm 10 can therefore improve the quality of radiation sounds.

          It is easy to use a variety of colors during the manufacture  
15 process of the speaker diaphragm 10 and the structure itself is characteristic. An excellent outer appearance with a strong visual impression can be provided.

          The invention is not limited only to the above-described embodiment, but various modifications and applications are possible.  
20 For example, in the embodiment, although the slanted area has three projections and three recesses, the number of projections and recesses may be set as desired so long as the mechanical strength of the speaker diaphragm can be increased and division vibrations can be suppressed. In this case, it is preferable to use the odd number  
25 of projections in order to forcibly suppress four-division vibrations

5 which greatly degrade the characteristics of a speaker diaphragm.

The material of the speaker diaphragm is not limited only to polypropylene, but other resin capable of ejection molding may also be used.

#### INDUSTRIAL ADAPTABILITY

10 As described above, according to the present invention, the mechanical strength of the speaker diaphragm can be increased by incorporating the three-dimensional structure like the screw propeller, and the pressure applied to the surface of the speaker diaphragm can be lowered by giving the rotation force to air which is  
15 likely to flow toward the central area. It is therefore possible to efficiently suppress the generation of division vibrations and improve the quality of radiation sounds.

Further, according to the present invention, the speaker diaphragm has the three-dimensional structure like the screw  
20 propeller and coloring is easy during manufacture processes. An excellent outer appearance can therefore be provided.

5 WHAT IS CLAIMED IS:

1. A speaker diaphragm having a generally cone shape, comprising:  
a plurality of projections forming a periodical structure along a circumferential direction in a slanted area of the speaker diaphragm, each projection extending radially from a central area to an edge  
10 portion and curving along the circumferential direction as the speaker diaphragm comes near to the edge portion; and  
a plurality of recesses formed between the plurality of projections,  
wherein at least one surface is curved in an area from each  
15 projection to each recess.
2. A speaker diaphragm according to claim 1, wherein one surface in an area from each projection to each recess has a bent portion.
- 20 3. A speaker diaphragm according to claim 1 or 2, wherein the odd number of projections are formed as counted along the circumferential direction, and the projection has a cross section like a screw propeller.
- 25 4. A speaker diaphragm according to claim 1, 2 or 3, wherein a

5 bottom area of the recess is made thicker than another area.

5. A speaker diaphragm having a general cone shape, the speaker diaphragm having projections and recesses forming a screw propeller shape to give a force along the circumferential direction to air flowing  
10 toward a central area of the speaker diaphragm.

6. A speaker diaphragm according any one of claims 1 to 5, wherein the speaker diaphragm is manufactured by ejection molding of material containing polypropylene as a main composition.

15

5 ABSTRACT OF THE DISCLOSURE

A speaker diaphragm 10 is provided having an improved quality of radiation sounds and a good outer appearance. The speaker diaphragm has in its slanted area projections typically represented by a peak line 4 and recesses typically represented by a  
10 bottom line 5. The projection typically represented by the peak line extends radially from the central area to the edge portion, and curves along the circumferential direction as it comes near to the edge portion. While the speaker diaphragm 10 vibrates at a large amplitude and moves toward the bottom side thereof, a rotation force  
15 is applied to air which is likely to concentrate upon the central area to thereby lower the air pressure to the central area. The speaker diaphragm 10 has a three-dimensional structure like a screw propeller so that the mechanical strength of the speaker diaphragm 10 can be increased over the whole area thereof and division  
20 vibrations can be suppressed. The speaker diaphragm is manufactured by ejection molding of material containing polypropylene as its main composition so that a variety of colors can be easily used during manufacture processes. In cooperation with the unique structure like the screw propeller, a strong visual  
25 impression is given.

FIG. 1

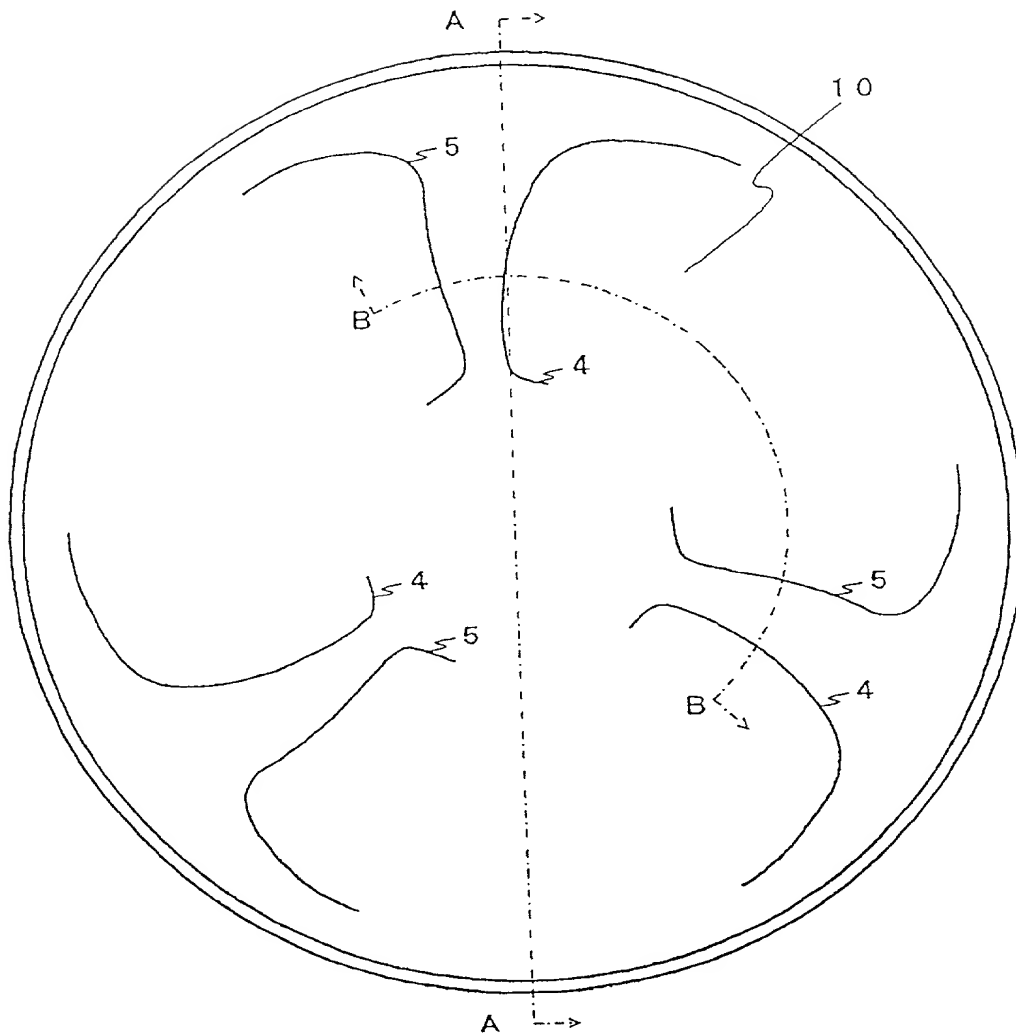


FIG. 2

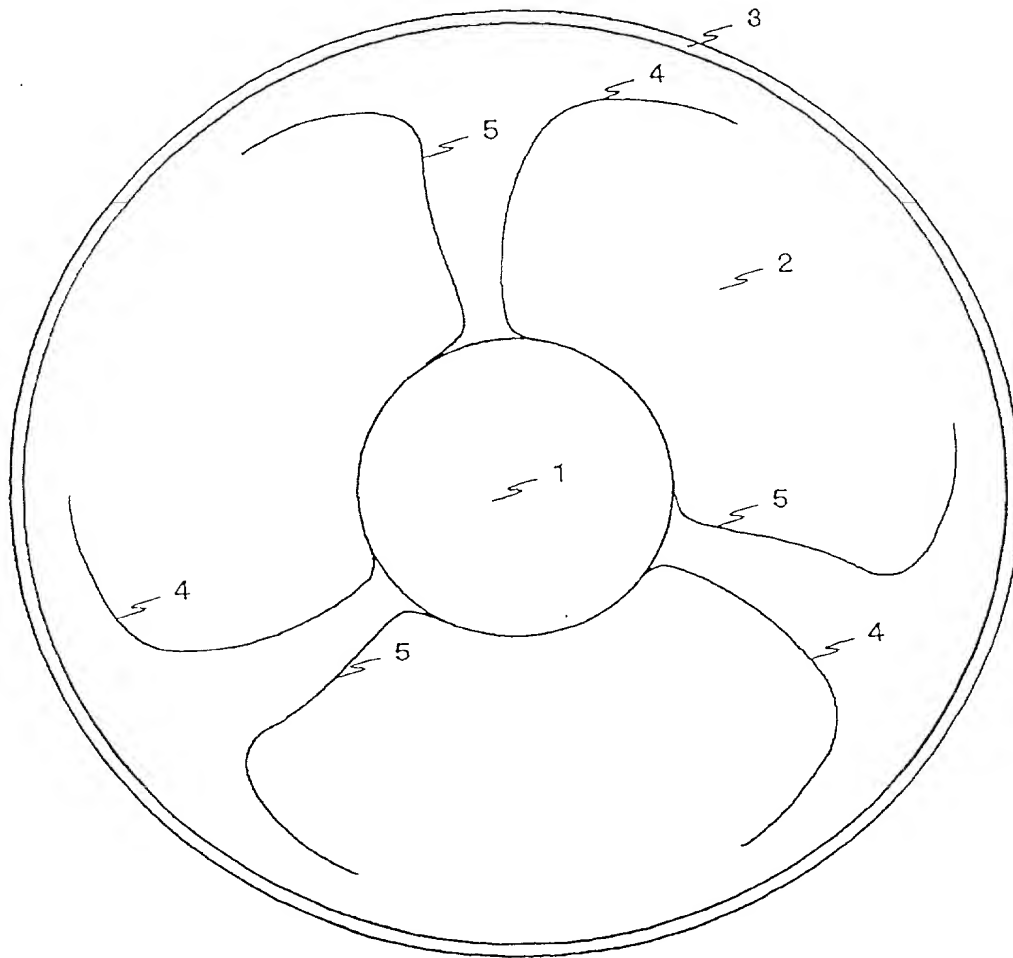


FIG. 3

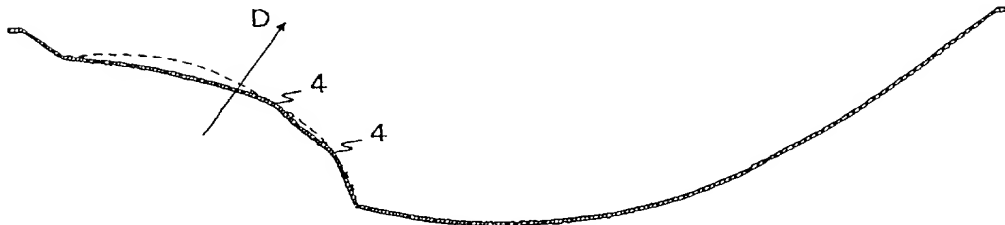


FIG. 4

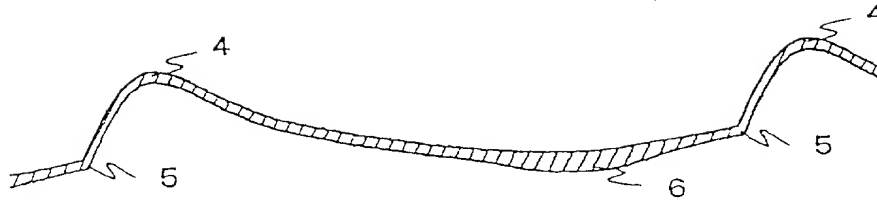


FIG. 5

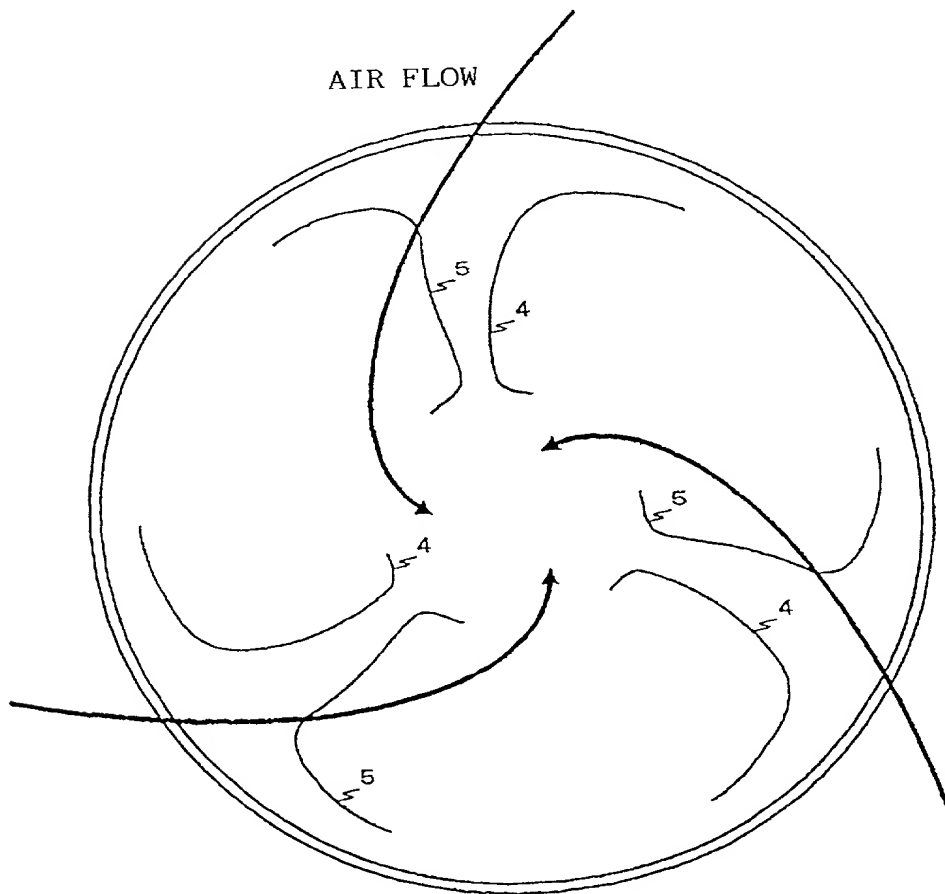
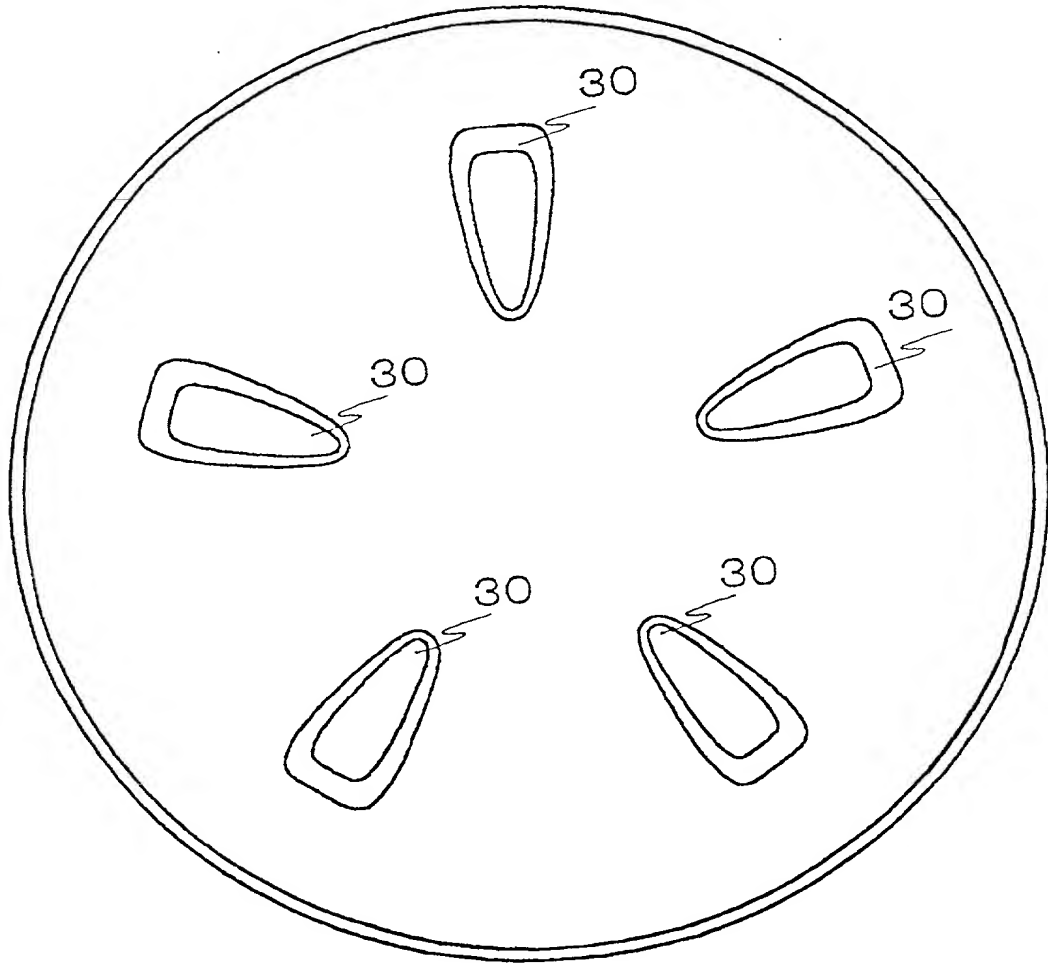




FIG. 6



**COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY**  
 (Includes Reference to PCT International Applications)

Attorney Docket No:

As a below named inventor, I hereby declare that:

My residence post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

**SPEAKER DIAPHRAGM**

the specification of which (check only one item below):

☐ is attached hereto.

☐ was filed as United States application

Serial No.

on

and was amended

on \_\_\_\_\_ (if applicable).

☒ was filed as PCT international application

Number PCT/JP00/02662

on April 24, 2000

and was amended under PCT Article 19

on \_\_\_\_\_ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations. § 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent or inventor's certificate or of any PCT international applications(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

**PRIOR FOREIGN/PCT APPLICATION(S) AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. 119:**

COUNTRY	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 35 USC 119
Japan	Patent Appln. No. 11-114309	22. 04. 99	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO
			<input type="checkbox"/> YES <input type="checkbox"/> NO
			<input type="checkbox"/> YES <input type="checkbox"/> NO
			<input type="checkbox"/> YES <input type="checkbox"/> NO
			<input type="checkbox"/> YES <input type="checkbox"/> NO

**COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY**

(Includes Reference to PCT International Applications)

Attorney Docket No:

I hereby claim the benefit under Title 35, United States Code, § 119(e) or § 120, as applicable of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, § 1.56 which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application:

**PRIOR U.S. APPLICATIONS OR PCT INTERNATIONAL APPLICATIONS DESIGNATING THE U.S. FOR BENEFIT UNDER 35 U.S.C. 120:**

U.S. APPLICATIONS			STATUS (Check one)		
U.S. APPLICATION NUMBER	U.S. FILING DATE		PATENTED	PENDING	ABANDONED
<b>PCT APPLICATIONS DESIGNATING THE U.S.</b>					
PCT APPLICATION NO.	PCT FILING DATE	U.S. SERIAL NUMBERS ASSIGNED (if any)			

**POWER OF ATTORNEY:** As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (List name and registration number)

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

The undersigned hereby authorize any U.S. attorney or agent named herein to accept and follow instructions from **Nobuaki KATO and Nobumitsu ASAHI** as to any action to be taken in the Patent and Trademark Office regarding this application without direct communication between the U.S. attorney or agent and the undersigned. In the event of a change in the persons from whom instructions may be taken, the U.S. attorneys or agents named herein will be so notified by the undersigned.

FULL NAME OF SOLE OR FIRST INVENTOR

Junichi HAYAKAWA

INVENTOR'S SIGNATURE

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FULL NAME OF SEVENTH JOINT INVENTOR (if any)		INVENTOR'S SIGNATURE	DATE
RESIDENCE (City, State & Country)			CITIZENSHIP
POST OFFICE ADDRESS (Complete Address including City, State & Country)			
FULL NAME OF EIGHTH JOINT INVENTOR (if any)		INVENTOR'S SIGNATURE	DATE
RESIDENCE (City, State & Country)			CITIZENSHIP
POST OFFICE ADDRESS (Complete Address including City, State & Country)			